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Toxicological Profile for

BERYLLIUM

U.S. DEPARTMENT OF HEALTH & HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

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TOXICOLOGICAL PROFILE FOR BERYLLIUM

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1. PUBLIC HEALTH STATEMENT

This Statement was prepared to give you information about beryllium and to emphasize the human health effects that may result from exposure to it. The Environmental Protection Agency (EPA) has identified 1,300 sites on its National Priorities List (NPL). Beryllium has been found in at least 349 of these sites including 5 in Puerto Rico. However, we do not know how many of the 1,300 NPL sites have been evaluated for beryllium. As EPA evaluates more sites, the number of sites at which beryllium is found may change. This information is important for you to know because beryllium may cause harmful health effects and because these sites are potential or actual sources of human exposure to beryllium.

When a chemical is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment as a chemical emission. This emission, which is also called a release, does not always lead to exposure. You can be exposed to a chemical only when you come into contact with the chemical. You may be exposed to it in the environment by breathing, eating, or drinking substances containing the chemical or from skin contact with it.

If you are exposed to a hazardous chemical such as beryllium, several factors will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), the other chemicals to which you are exposed, and your individual characteristics such as age, sex, nutritional status, family traits, life style, and state of health.

1.1 WHAT IS BERYLLIUM?

Beryllium is a hard, grayish element that does not occur naturally. The element does occur as a chemical component of certain rocks, coal and oil, soil, and volcanic dust. Two kinds of mineral rocks, bertrandite and beryl, are mined commercially for the recovery of beryllium. Very pure gem-quality beryl is better known as either aquamarine (blue or blue-green) or emerald (green). Beryllium is also present in a variety of compounds. They do not have any particular smell. There are two types of beryllium compounds, those that dissolve in water and those that do not.

Most of the beryllium ore that is mined is converted into alloys (mixtures of metals). Most of these alloys are used in making electrical and electronic parts or as construction materials for machinery and molds for plastics. Pure beryllium metal has applications in nuclear weapons and reactors, aircraft and space vehicle structures and instruments, X-ray machines, and mirrors. Beryllium oxide is also made from beryllium ores and is used to make specialty ceramics for electrical and high-technology applications. More information on the chemical and physical properties, and production and use is found in Chapters 3 and 4.

1.2 WHAT HAPPENS TO BERYLLIUM WHEN IT ENTERS THE ENVIRONMENT?

Beryllium enters the air, water, and soil as a result of natural and human activities. Emissions from burning coal and oil increase beryllium levels in air. Beryllium enters waterways from the wearing away of rocks and soil. Most of the man-made beryllium that enters waterways comes when industry dumps waste water and when beryllium dust in the air from industrial activities settles over water. Beryllium, as a chemical component, occurs naturally in soil; however, disposal of coal ash, incinerator ash, and industrial wastes may increase the concentration of beryllium in soil. In air, beryllium compounds are present mostly as fine dust particles. The dust eventually settles over land and water. Rain and snow aid in the removal of beryllium from air. Sufficiently small beryllium particles may remain airborne for about 10 days. Most of the beryllium in water settles in the material on the bottom. Beryllium compounds remain in ocean water for a few hundred years before settling to the bottom of the ocean. Fish do not accumulate beryllium from water into their bodies to any great extent. A major portion of beryllium in soil does not dissolve in water but remains bound to soil, so it is not very likely to move deeper into the ground and enter groundwater. In the environment, chemical reactions can change the water-soluble beryllium compounds into insoluble forms. In some cases, water-insoluble beryllium compounds can change to soluble forms. Exposure to water-soluble beryllium compounds in the environment, in general, will pose a greater threat to human health than water-insoluble forms. More information about the fate and movement of beryllium in the environment is found in Chapter 5.

1.3 HOW MIGHT I BE EXPOSED TO BERYLLIUM?

You can be exposed to low levels of beryllium by breathing air, eating food, or drinking water that contains beryllium. In the United States, the average concentration of beryllium in air is 0.03 nanograms (ng) (1 ng = 1 billionth of a gram) in a cubic meter (ng/m^3) of air. In U.S. cities, the average air concentration is higher, and its value is 0.2 ng/m^3 of air. Cities have higher levels of beryllium in the air because beryllium is released from burning coal and fuel oil. Beryllium was not found in 5% of 1,577 drinking water samples obtained throughout the United States. Of these samples, the average beryllium concentration was only 190 ng in a liter (L) of water. Beryllium, as a chemical component, is naturally found in some food. The concentration of beryllium in both raw carrots and field corn grown in the United States is less than 25 micrograms (μg) (1 μg = 1 millionth of a gram) in a kilogram (kg) of the fresh vegetables. The intake of beryllium for most people will be very small.

In certain workplaces you can be exposed to higher than normal levels of beryllium, mostly in the form of beryllium oxide and beryllium metal. Occupational exposure to beryllium occurs at places where the chemical is mined, processed, and converted into metal, alloys, and other chemicals. Workers engaged in machining metals containing beryllium, in recycling beryllium from scrap alloys, or in using beryllium products may also be exposed to higher

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levels of beryllium. An estimated 18,000 workers may be exposed to beryllium and beryllium oxide in the workplace.

As a member of the general public, you may be exposed to higher than normal levels of beryllium if you live near an industry that processes or uses beryllium. People who live near hazardous landfill sites that contain high concentrations of beryllium may also be exposed to higher than normal levels of beryllium. Beryllium, as a chemical component, occurs naturally in tobaccos and can be inhaled from cigarette smoke. People who smoke may breathe considerably more beryllium than people who do not smoke.

Beryllium metal and metal alloys may be found in consumer products such as electronic devices (e.g., televisions, calculators, and personal computers) and special nonsparking tools. More information about beryllium exposure can be found in Chapter 5.

1.4 HOW CAN BERYLLIUM ENTER AND LEAVE MY BODY?

Beryllium can enter your body if you breathe air, eat food, or drink water containing it. Beryllium will not enter your body from skin contact with the metal unless the skin is scraped or cut and beryllium particles become imbedded in the wound. Only a small amount of beryllium may enter your body if your skin comes into contact with a beryllium salt dissolved in water. When you breathe air containing beryllium, beryllium particles can be deposited in the lungs. The beryllium that you breathe in slowly dissolves in the lungs and moves slowly into the bloodstream. Some of the beryllium deposited in the lungs can be moved to the mouth and then swallowed; the rest can remain in your lungs for a long time. If you eat food or drink water that contains beryllium, less than 1% passes from your stomach and intestines into the bloodstream. Therefore, most of the beryllium that you swallow leaves your body through the feces without entering the bloodstream. The small amount of beryllium that moves from the lungs, stomach, and intestines into the bloodstream is carried by the blood to the kidneys. Beryllium leaves the kidneys by the urine. Some beryllium can also be carried by the blood to the liver and bones where it may remain for long periods of time. If you swallow beryllium, beryllium leaves the body in a few days. However, if you inhale beryllium, it may take months to years before your body rids itself of beryllium. This is because it takes a long time before all the beryllium in the lungs enters the bloodstream or is swallowed. For more information, please read Chapter 2.

1.5 HOW CAN BERYLLIUM AFFECT MY HEALTH?

Beryllium is a metal that can be harmful when you breathe it. The effects depend on how much and how long you are exposed to it. When you breathe it in, beryllium can damage your lungs. When you breathe in large amounts of soluble beryllium compounds, the lung damage resembles pneumonia with reddening and swelling of the lungs. This condition is

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called acute beryllium disease. In this case, if you stop breathing air with beryllium in it, the lung damage may heal. Some people can become sensitive to beryllium. This is known as hypersensitivity or allergy. If you become sensitive (allergic) to beryllium, you will develop an immune or inflammatory reaction to amounts of beryllium that do not cause effects in people who are not sensitive to beryllium. When this occurs, white cells accumulate around the beryllium and form a chronic inflammatory reaction called granulomas (granulomas are not tumors). This condition is called chronic beryllium disease. This disease can occur long after exposure to small amounts of either the soluble or the insoluble forms of beryllium. If you have this disease you may feel weak, tired, and have difficulty breathing.

Although the soluble and insoluble forms of beryllium can cause chronic beryllium disease, workers breathing air containing beryllium at less than 0.002 milligrams (mg) (1 mg = 1 thousandth of a gram of beryllium) in a cubic meter (mg/m^3) (a level that government rules permit in the workplace) will probably not develop lung damage as a result of exposure. Both the short-term, pneumonia-like disease and the chronic beryllium disease can be fatal. Long periods of exposure to beryllium have been reported to cause cancer in laboratory animals, but some of these studies are not reliable. Some studies of workers reported an increased risk of lung cancer, but these studies are not conclusive, and new studies are being performed. The Department of Health and Human Services has determined that beryllium and certain beryllium compounds may reasonably be anticipated to be carcinogens. The International Agency for Research on Cancer has determined that beryllium and beryllium compounds are probably carcinogenic to humans. The EPA has determined that beryllium is a probable human carcinogen. We have no evidence that breathing air, eating food, or drinking water that contains beryllium or having skin contact with beryllium has any effects on reproduction or causes birth defects in humans or animals. Swallowing beryllium has not been reported to cause effects in humans because very little beryllium can move from the stomach and intestines into the bloodstream. Beryllium contact with skin that has been scraped or cut can cause rashes or ulcers. If you have developed an allergy to beryllium and have skin contact with it, you can get granulomas on the skin. These skin granulomas appear as a rash or as nodules. The skin granulomas are formed in the same way that lung granulomas are formed in sensitive people. For more information on how beryllium can affect your health, please read Chapter 2.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO BERYLLIUM?

Beryllium can be measured in the urine and blood, but the amount of beryllium in the urine or blood may not reflect the amount to which you were exposed. The measurement of beryllium in urine and blood may not determine how recently you were exposed. Small amounts of human lung and skin can be removed from the body and examined to determine whether beryllium is present in these tissues. These tests can be done in a doctor's office or

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in a hospital. While high levels of beryllium in urine, blood, or tissues indicate that you were exposed to an excessive amount of beryllium, normal levels of beryllium do not necessarily mean that you were not exposed to an excessive amount. There is also a test that uses blood cells or cells washed out of the lung. If these cells start growing in the presence of beryllium, the possibility is strong that you have become sensitive to beryllium and have chronic beryllium disease. For more information, please read Chapters 2 and 6.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The National Institute for Occupational Safety and Health (NIOSH) recommends a standard for occupational exposure of $0.5 \mu\text{g beryllium}/\text{m}^3$ of workroom air during an 8-hour shift to protect workers from a concern that beryllium may cause cancer. The Occupational Safety and Health Administration (OSHA) has set a limit of $2 \mu\text{g beryllium}/\text{m}^3$ of workroom air for an 8-hour work shift. The Environmental Protection Agency restricts the amount of beryllium emitted into the environment by industries that process beryllium ores, metal, oxide, alloys, or waste to 10 grams (g) in a 24-hour period, or to an amount that would result in atmospheric levels of $0.01 \mu\text{g beryllium}/\text{m}^3$ of air, averaged over a 30-day period. For more information, please read Chapter 7.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, E-29
Atlanta, Georgia 30333

This agency can also provide you with information on the location of the nearest occupational and environmental health clinic. These clinics specialize in the recognition, evaluation, and treatment of illnesses resulting from exposure to hazardous substances.